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AMTEST AIR QUALITY, INC.

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SOURCE

EMISSION

EVALUATION

July 20, 1994

Prepared For:

BALL GLASS CONTAINER CORPORATION
SEATTLE PLANT
FURNACES #2, #3, #4 & #5
METHOD 6C, 7E, 10 AND 201A TESTING
SEATTLE, WASHINGTON
MAY 17-20, 1994

Submitted by:

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We certify that the information contained herein is accurate and complete to the best of our knowledge.

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1.0
INTRODUCTION

The purpose of this source emission evaluation was to quantify emissions of particulate matter less than 10 microns in diameter (PM_{10}), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and carbon monoxide (CO) from four (4) furnaces at Ball Glass Container Corporation's facility in Seattle, Washington. Ball Glass Container Corporation's Muncie, Indiana office contracted Am Test-Air Quality, Inc. based in Preston, Washington to perform source tests at the south and north stacks of Furnace #2, the Furnace #3 stack, the Furnace #4 stack and the Furnace #5 stack.

Environmental Protection Agency (EPA) methods used for these tests are presented in the July 1, 1993 edition of Title 40, Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A, Methods 1, 2, 3A, 4, 5, 6C, 7E and 10; and in the July 1, 1993 edition of the EPA document Title 40 CFR Parts 1-51 (40 CFR 51), Appendix M, Method 201A. Puget Sound Air Pollution Control Agency (PSAPCA) Regulation I, Method 5 back-half analysis procedures were used to quantify condensible matter emissions using a combined Method 5/201A sample train. Methods 1 and 2 were performed to measure the stack gas temperature and velocity for calculating volumetric flow rate. Method 3A was performed to determine the molecular weight of the stack gas based on measurements of the oxygen (O_2) and carbon dioxide (CO_2) concentration in the gas stream. Method 4 was performed to measure the moisture content of the stack gas. EPA Method 201A was performed to quantify PM_{10} emissions. This method is titled "Determination of PM_{10} Emissions (Constant Sampling Rate Procedures)". A heated out-of-stack filter was used downstream of the PM_{10} sample device, therefore, Am Test identifies this configuration as Method 5/201A.

Condensible particulate matter was quantified by performing an extraction of the back-half portion of the Method 5 sample train per PSAPCA's analysis procedures. Method 6C was performed to determine the SO_2 emission concentration using an ultraviolet analyzer. Method 7E was performed to determine the NO_x emission concentration using a chemiluminescent analyzer. Method 10 was performed to determine the CO emission concentration using a non-dispersive infrared (NDIR) analyzer. Three (3) tests of each type were performed at each site on May 17-20, 1994.

Mr. Kevin P. Orton, Ms. Stacia G. Dugan, Mr. E. Ray Lawrence and Ms. Wendy A. Linn of Am Test-Air Quality, Inc. performed the field sampling. Sample recovery and laboratory analysis of the Method 201A samples were performed by Ms. Linn and Stacy Akin of Am Test. Data reduction, quality assurance review and final report preparation was performed by Mr. Kris A. Hansen, Ms. Angela F. Blaisdell, Ms. Cassie B. Heaton, Ms. Judy A. Aasland and Ms. Akin of Am Test. This test program was coordinated by Mr. Marvin C. Gridley of Ball Glass Container Corporation. Mr. Doug Coburn, a Plant Engineer for Ball Glass Container Corporation in Seattle, provided on-site coordination.

2.0
SUMMARY OF RESULTS

The following sections of this report present the results from the emission tests performed on May 17-20, 1994 at the exhaust stacks of Furnaces #2, #3, #4 and #5. Furnaces #2, #3 and #5 are oxyfuel sources, while Furnace #4 is a traditional induction-draft furnace. The characteristics of each furnace are described in Section 4.0 of this report. Refer to the Table of Contents to locate specific information for each test method. The summary tables contain information obtained from computer printouts of results for each individual run which are included in Appendix A of this report. Appendix B of this report contains example calculations of results, raw gaseous emissions data and copies of the original field data sheets. Appendix C of this report contains the source and process information obtained during the emissions tests. Appendix D of this report contains miscellaneous supporting information.

2.1 EPA Method 201A - PM_{10}

EPA Method 201A samples were collected to quantify the percentage of particulate matter less than (<) 10 microns in diameter (PM_{10}) at the exhaust stacks of Furnace #2, #3, #4 and Furnace #5 at Ball Glass Container Corporation. Three (3) PM_{10} samples were collected at the Furnace #2 south stack on May 17, 1994. Three (3) PM_{10} samples were collected at the Furnace #2 north stack on May 17, 1994. Three (3) PM_{10} samples were collected at the Furnace #3 stack on May 18, 1994. Three (3) PM_{10} samples were collected at the Furnace #4 stack on May 19, 1994. Three (3) PM_{10} samples were collected at the Furnace #5 stack on May 20, 1994. Samples were collected over approximate 120-minute sample periods to assure adequate detection. The results of the fifteen (15) EPA Method 201A tests for quantifying particulate

matter and PM_{10} emissions from the four (4) sources are summarized in Table 2.1 below, and the following computer printouts titled "Summary of Results - Methods 1, 2, 3A, 4 and 201A".

The cut point diameter (D_{50}) for each run is presented in units of micrometers, or microns (μm). The particulate matter emission concentrations are presented in units of grains per dry standard cubic foot (gr/dscf). For Furnace #4, the total particulate matter emission concentration in units of gr/dscf is presented dilution corrected (using the airflow calculated with the dilution duct airflow. The particulate matter emission concentrations are presented as greater than (>) PM_{10}, less than (<) PM_{10} with condensibles included, total with condensibles included and percent < PM_{10} with condensibles included. "Condensibles" refers to the condensible particulate matter which passes through the filter and condenses in the impingers of the sample train (back-half). The particulate matter emission concentration in units of gr/dscf without condensibles and in milligrams per dry standard cubic meter was also calculated for each run. Emission rates are presented with and without condensibles and total in units of pounds per hour (lb/hr). The emission concentrations for Furnace #2 North and South stacks are calculated individually and are averaged. The Furnace #2 emission rate is the sum of the emission rates from the North and South stacks.

Table 2.1 Summary of particulate matter emission test results from samples collected at the exhaust stacks of Furnaces #2, #3, #4 and #5 at Ball Glass Container Corporation in Seattle, Washington on May 17-20, 1994.

Sample Run #	Cut Point Diam D_{50} (um)	> PM_{10} Emission Conc. w/Cond. (gr/dscf)	< PM_{10} Emission Conc. w/Cond. (gr/dscf)	Total Emission Conc. w/Cond. (gr/dscf)	< PM_{10} Emission Rate w/Cond. (lb/hr)	Percent < PM_{10} w/Cond. (%)	
Furnace #2 (South)							
Run 1	9.63	0.0009	0.038	0.039	1.68	97.7	144.6 T/D
Run 2	9.68	0.0008	0.028	0.028	1.23	97.1	
Run 3	10.01	0.0005	0.031	0.032	1.34	98.4	
Average	9.77	0.0007	0.032	0.033	1.42	97.7	
Furnace #2 (North)							
Run 1	10.09	0.0006	0.028	0.029	1.43	98.0	
Run 2	10.18	0.0000	0.022	0.022	1.08	100.0	
Run 3	10.23	0.0003	0.022	0.022	1.12	98.7	
Average	10.17	0.0003	0.024	0.024	1.21	98.9	
Furnace #2 (Avg)		0.0005	0.028	0.029		98.3	
Furnace #2 (Total)					2.63		0.44 #/T
Furnace #3							
Run 1	9.93	0.0002	0.025	0.025	4.59	99.2	166.8 T/D
Run 2	10.14	0.0009	0.024	0.025	4.43	96.6	
Run 3	10.24	0.0007	0.017	0.017	3.12	96.2	
Average	10.10	0.0006	0.022	0.022	4.05	97.3	0.58 #/T
Furnace #4							131.3 T/D
Run 1	10.03	0.011	0.043*	0.065*	3.07	65.6	
Run 2	9.99	0.024	0.052*	0.105*	4.73	50.1	
Run 3	10.12	0.007	0.058*	0.071*	6.10	82.1	
Average	10.05	0.014	0.051*	0.080*	4.63	65.9	0.85 #/T
*Dilution Corrected							
Furnace #5							130.7 T/D
Run 1	10.04	0.0009	0.026	0.027	2.76	96.7	
Run 2	10.27	0.002	0.025	0.027	2.57	91.4	
Run 3	10.22	0.001	0.022	0.023	2.26	94.6	
Average	10.18	0.001	0.024	0.026	2.53	94.2	0.46 #/T

AMTEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 1, 2, 3A, 4 AND 201A
AM TEST - AIR QUALITY, INC.

FILE NAME: S708\BALLS2SM
CLIENT: Ball Glass Container Corporation
LOCATION: Seattle, Washington

FURNACE #2 SOUTH STACK

	RUN #1	RUN #2	RUN #3	AVERAGE
LAB #:	5739	5740	5741	
DATE:	5/17/94	5/17/94	5/17/94	
START TIME:	09:45	13:38	17:03	
STOP TIME:	11:47	15:53	19:15	
SAMPLE LENGTH (minutes):	110.96	118.55	115.73	
VOLUME SAMPLED (cubic feet):	49.902	52.883	49.293	50.693
VOLUME SAMPLED (dry std. cubic feet):	49.064	52.068	48.260	49.797
VOLUME SAMPLED (dry std. cubic meters):	1.390	1.475	1.367	1.411
STACK GAS MOISTURE (percent):	9.94	9.70	9.97	9.87
BAROMETRIC PRESSURE (inches of Hg):	29.95	29.95	29.95	29.95
STATIC PRESSURE (inches of H2O):	-0.25	-0.29	-0.30	-0.28
STACK PRESSURE (inches of Hg):	29.93	29.93	29.93	29.93
STACK GAS TEMPERATURE (degrees F.):	603.6	587.3	585.2	592.0
STACK GAS TEMPERATURE (degrees R.):	1063.6	1047.3	1045.2	1052.0
CARBON DIOXIDE (percent):	7.5	7.2	7.4	7.4
OXYGEN (percent):	18.9	19.0	19.0	19.0
CARBON MONOXIDE (ppm):	229.8	8.9	3.5	80.7
MOLECULAR WEIGHT (dry, g/g-mole):	29.96	29.91	29.94	29.9
MOLECULAR WEIGHT (wet, g/g-mole):	28.77	28.76	28.75	28.8
GAS VISCOSITY (micropoises):	310.5	306.3	305.5	307.4
AVERAGE VELOCITY HEAD (inches of H2O):	0.270	0.265	0.249	0.261
PITOT TUBE Cp.	0.84	0.84	0.84	
STACK GAS VELOCITY (feet per second):	41.5	40.8	39.5	40.60
STACK DIAMETER (inches):	29.25	29.25	29.25	
STACK AREA (square feet):	4.67	4.67	4.67	
STACK GAS AIRFLOW (dry std. cubic feet per min.):	5191.7	5200.9	5032.5	5141.7
STACK GAS AIRFLOW (actual cubic feet per min.):	11607.3	11420.6	11062.5	11363.5
NOZZLE DIAMETER (inches):	0.264	0.264	0.264	
ISOKINETICS (percent):	105	104	102	
CUT-POINT DIAMETER (D50):	9.63	9.68	10.01	9.77
> PM10 PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.0009	0.0008	0.0005	0.0007
> PM10 PARTICULATE MATTER EMISSION RATE (lb/hr):	0.039	0.037	0.022	0.033
< PM10 PARTICULATE MATTER CONC. W/O CONDENSIBLES (gr/dscf):	0.028	0.023	0.025	0.025
< PM10 PARTIC. MATTER EMISSION RATE W/O CONDENSIBLES (lb/hr):	1.24	1.01	1.07	1.11
< PM10 PARTICULATE MATTER CONC. W/CONDENSIBLES (gr/dscf):	0.038	0.028	0.031	0.032
< PM10 PARTIC. MATTER EMISSION RATE W/CONDENSIBLES (lb/hr):	1.68	1.23	1.34	1.42
TOTAL PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.039	0.028	0.032	0.033
TOTAL PARTICULATE MATTER CONCENTRATION (mg/dscm):	88.2	65.0	72.5	75.2
TOTAL PARTICULATE MATTER EMISSION RATE (lb/hr):	1.72	1.27	1.37	1.45
PERCENT PARTICULATE MATTER < PM10 W/O CONDENSIBLES (%):	96.9	96.5	98.0	97.1
PERCENT PARTICULATE MATTER < PM10 W/CONDENSIBLES (%):	97.7	97.1	98.4	97.7

AMTEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 1, 2, 3A, 4 AND 201A
AM TEST - AIR QUALITY, INC.

FILE NAME: S708\BALLN2SM
CLIENT: Ball Glass Container Corporation
LOCATION: Seattle, Washington

FURNACE #2 NORTH STACK

	RUN #1	RUN #2	RUN #3	AVERAGE
LAB #:	5736	5737	5738	
DATE:	5/17/94	5/17/94	5/17/94	
START TIME:	09:45	13:38	17:03	
STOP TIME:	12:02	15:53	19:13	
SAMPLE LENGTH (minutes):	124.8	118.7	122.4	
VOLUME SAMPLED (cubic feet):	51.741	49.482	50.919	50.714
VOLUME SAMPLED (dry std. cubic feet):	51.830	48.707	49.760	50.099
VOLUME SAMPLED (dry std. cubic meters):	1.468	1.379	1.409	1.419
STACK GAS MOISTURE (percent):	8.09	7.73	7.88	7.90
BAROMETRIC PRESSURE (inches of Hg):	29.95	29.95	29.95	29.95
STATIC PRESSURE (inches of H2O):	-0.30	-0.30	-0.30	-0.30
STACK PRESSURE (inches of Hg):	29.93	29.93	29.93	29.93
STACK GAS TEMPERATURE (degrees F.):	492.2	471.9	471.4	478.5
STACK GAS TEMPERATURE (degrees R.):	952.2	931.9	931.4	938.5
CARBON DIOXIDE (percent):	4.6	4.2	4.3	4.4
OXYGEN (percent):	18.9	19.1	19.2	19.1
CARBON MONOXIDE (ppm):	159.7	4.1	0.2	54.7
MOLECULAR WEIGHT (dry, g/g-mole):	29.49	29.44	29.46	29.5
MOLECULAR WEIGHT (wet, g/g-mole):	28.56	28.55	28.55	28.6
GAS VISCOSITY (micropoises):	281.6	276.5	276.3	278.1
AVERAGE VELOCITY HEAD (inches of H2O):	0.297	0.287	0.297	0.294
PITOT TUBE Cp:	0.84	0.84	0.84	
STACK GAS VELOCITY (feet per second):	41.3	40.2	40.9	40.80
STACK DIAMETER (inches):	29.25	29.25	29.25	
STACK AREA (square feet):	4.67	4.67	4.67	
STACK GAS AIRFLOW (dry std. cubic feet per min.):	5894.3	5884.1	5978.6	5919.0
STACK GAS AIRFLOW (actual cubic feet per min.):	11563.0	11253.0	11445.3	11420.4
NOZZLE DIAMETER (inches):	0.233	0.233	0.233	
ISOKINETICS (percent):	111	110	107	
CUT-POINT DIAMETER (D50):	10.09	10.18	10.23	10.17
> PM10 PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.0006	0.0000	0.0003	0.0003
> PM10 PARTICULATE MATTER EMISSION RATE (lb/hr):	0.029	0.000	0.014	0.014
< PM10 PARTICULATE MATTER CONC. W/O CONDENSIBLES (gr/dscf):	0.022	0.019	0.018	0.020
< PM10 PARTIC. MATTER EMISSION RATE W/O CONDENSIBLES (lb/hr):	1.11	0.944	0.918	0.991
< PM10 PARTICULATE MATTER CONC. W/CONDENSIBLES (gr/dscf):	0.028	0.022	0.022	0.024
< PM10 PARTIC. MATTER EMISSION RATE W/CONDENSIBLES (lb/hr):	1.43	1.08	1.12	1.21
TOTAL PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.029	0.022	0.022	0.024
TOTAL PARTICULATE MATTER CONCENTRATION (mg/dscm):	66.2	49.2	50.8	55.4
TOTAL PARTICULATE MATTER EMISSION RATE (lb/hr):	1.46	1.08	1.14	1.23
PERCENT PARTICULATE MATTER < PM10 W/O CONDENSIBLES (%):	97.5	100.0	98.5	98.7
PERCENT PARTICULATE MATTER < PM10 W/CONDENSIBLES (%):	98.0	100.0	98.7	98.9

AMTEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 1, 2, 3A, 4 AND 201A
AM TEST - AIR QUALITY, INC.

FILE NAME: S708\BALL3SM
CLIENT: Ball Glass Container Corporation
LOCATION: Seattle, Washington

	FURNACE #3 STACK			
	RUN #1	RUN #2	RUN #3	AVERAGE
LAB #:	5742	5743	5744	
DATE:	5/18/94	5/18/94	5/18/94	
START TIME:	09:35	12:25	15:05	
STOP TIME:	11:36	14:25	17:04	
SAMPLE LENGTH (minutes):	121.1	117.8	118.8	
VOLUME SAMPLED (cubic feet):	50.381	48.843	49.432	49.552
VOLUME SAMPLED (dry std. cubic feet):	51.215	48.979	49.614	49.936
VOLUME SAMPLED (dry std. cubic meters):	1.450	1.387	1.405	1.414
STACK GAS MOISTURE (percent):	6.50	5.46	4.00	5.32
BAROMETRIC PRESSURE (inches of Hg):	30.10	30.10	30.10	30.10
STATIC PRESSURE (inches of H2O):	-0.30	-0.32	-0.38	-0.33
STACK PRESSURE (inches of Hg):	30.08	30.08	30.07	30.08
STACK GAS TEMPERATURE (degrees F.):	325.1	322.5	323.7	323.8
STACK GAS TEMPERATURE (degrees R.):	785.1	782.5	783.7	783.8
CARBON DIOXIDE (percent):	2.4	2.3	2.3	2.3
OXYGEN (percent):	20.2	20.3	20.3	20.3
CARBON MONOXIDE (ppm):	0.1	0.1	0.0	0.1
MOLECULAR WEIGHT (dry, g/g-mole):	29.19	29.18	29.18	29.2
MOLECULAR WEIGHT (wet, g/g-mole):	28.46	28.57	28.73	28.6
GAS VISCOSITY (micropoises):	239.4	239.6	241.0	240.0
AVERAGE VELOCITY HEAD (inches of H2O):	0.416	0.402	0.408	0.409
PITOT TUBE Cp:	0.84	0.84	0.84	
STACK GAS VELOCITY (feet per second):	44.3	43.5	43.7	43.83
STACK DIAMETER (inches):	48.5	48.5	48.5	
STACK AREA (square feet):	12.8	12.8	12.8	
STACK GAS AIRFLOW (dry std. cubic feet per min.):	21572.8	21454.5	21870.5	21632.6
STACK GAS AIRFLOW (actual cubic feet per min.):	34126.1	33457.3	33645.7	33743.0
NOZZLE DIAMETER (inches):	0.197	0.197	0.197	
ISOKINETICS (percent):	119	118	116	
CUT-POINT DIAMETER (D50):	9.93	10.14	10.24	10.10
> PM10 PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.0002	0.0009	0.0007	0.0006
> PM10 PARTICULATE MATTER EMISSION RATE (lb/hr):	0.039	0.156	0.122	0.106
< PM10 PARTICULATE MATTER CONC. W/O CONDENSIBLES (gr/dscf):	0.021	0.020	0.014	0.018
< PM10 PARTIC. MATTER EMISSION RATE W/O CONDENSIBLES (lb/hr):	3.89	3.63	2.71	3.41
< PM10 PARTICULATE MATTER CONC. W/CONDENSIBLES (gr/dscf):	0.025	0.024	0.017	0.022
< PM10 PARTIC. MATTER EMISSION RATE W/CONDENSIBLES (lb/hr):	4.59	4.43	3.12	4.05
TOTAL PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.025	0.025	0.017	0.022
TOTAL PARTICULATE MATTER CONCENTRATION (mg/dscm):	57.3	57.1	39.6	51.3
TOTAL PARTICULATE MATTER EMISSION RATE (lb/hr):	4.63	4.59	3.24	4.15
PERCENT PARTICULATE MATTER < PM10 W/O CONDENSIBLES (%):	99.0	95.9	95.7	96.9
PERCENT PARTICULATE MATTER < PM10 W/CONDENSIBLES (%):	99.2	96.6	96.2	97.3

AMTEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 1, 2, 3A, 4 AND 201A
AM TEST - AIR QUALITY, INC.

FILE NAME: S708\BALL4SM
CLIENT: Ball Glass Container Corporation
LOCATION: Seattle, Washington

FURNACE #4 STACK

	RUN #1	RUN #2	RUN #3	AVERAGE
LAB #:	5745	5746	5747	
DATE:	5/19/94	5/19/94	5/19/94	
START TIME:	09:35	12:45	16:03	
STOP TIME:	12:07	15:13	18:30	
SAMPLE LENGTH (minutes):	137.04	135.85	124.03	
DILUTION AIRFLOW (dscf/min):	9251.9	12092.8	11583.4	
VOLUME SAMPLED (cubic feet):	57.930	58.656	53.352	56.646
VOLUME SAMPLED (dry std. cubic feet):	58.117	57.991	52.005	56.038
VOLUME SAMPLED (dry std. cubic meters):	1.646	1.642	1.473	1.587
STACK GAS MOISTURE (percent):	5.21	5.49	5.51	5.40
BAROMETRIC PRESSURE (inches of Hg):	30.00	30.05	30.05	30.03
STATIC PRESSURE (inches of H2O):	-0.51	-0.70	-0.85	-0.69
STACK PRESSURE (inches of Hg):	29.96	30.00	29.99	29.98
STACK GAS TEMPERATURE (degrees F.):	374.8	398.8	405.2	392.9
STACK GAS TEMPERATURE (degrees R.):	834.8	858.8	865.2	852.9
CARBON DIOXIDE (percent):	2.3	2.6	2.8	2.6
OXYGEN (percent):	17.4	16.7	16.5	16.9
CARBON MONOXIDE (ppm):	0.1	0.1	0.1	0.1
MOLECULAR WEIGHT (dry, g/g-mole):	29.06	29.08	29.11	29.1
MOLECULAR WEIGHT (wet, g/g-mole):	28.49	28.48	28.50	28.5
GAS VISCOSITY (micropoises):	251.8	257.5	259.1	256.1
AVERAGE VELOCITY HEAD (inches of H2O):	0.610	1.035	1.154	0.933
PITOT TUBE Cp:	0.84	0.84	0.84	
STACK GAS VELOCITY (feet per second):	55.5	73.3	77.6	68.80
STACK DIAMETER (inches):	40.25	40.25	40.25	
STACK AREA (square feet):	8.84	8.84	8.84	
STACK GAS AIRFLOW (dry std. cubic feet per min.):	17650.0	22627.2	23788.6	21355.3
STACK GAS AIRFLOW (actual cubic feet per min.):	29400.1	38835.9	41158.8	36464.9
NOZZLE DIAMETER (inches):	0.215	0.197	0.150	
ISOKINETICS (percent):	84	79	127	
CUT-POINT DIAMETER (D50):	10.03	9.99	10.12	10.05
> PM10 PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.011	0.024	0.007	0.014
> PM10 PARTICULATE MATTER EMISSION RATE (lb/hr):	1.61	4.71	1.33	2.55
< PM10 PARTICULATE MATTER CONC. W/O CONDENSIBLES (gr/dscf):	0.012	0.018	0.021	0.017
< PM10 PARTIC. MATTER EMISSION RATE W/O CONDENSIBLES (lb/hr):	1.86	3.58	4.21	3.22
< PM10 PARTICULATE MATTER CONC. W/CONDENSIBLES (gr/dscf):	0.020	0.024	0.030	0.025
< PM10 PM CONC. W/CONDENSIBLES (Dilution Corrected, gr/dscf):	0.043	0.052	0.058	0.051
< PM10 PARTIC. MATTER EMISSION RATE W/CONDENSIBLES (lb/hr):	3.07	4.73	6.10	4.63
TOTAL PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.031	0.049	0.036	0.039
TOTAL PARTICULATE MATTER CONC. (Dilution Corrected, gr/dscf):	0.065	0.105	0.071	0.080
TOTAL PARTICULATE MATTER CONCENTRATION (mg/dscm):	70.8	111.4	83.4	88.5
TOTAL PARTICULATE MATTER EMISSION RATE (lb/hr):	4.68	9.44	7.43	7.18
PERCENT PARTICULATE MATTER < PM10 W/O CONDENSIBLES (%):	53.5	43.2	76.0	57.6
PERCENT PARTICULATE MATTER < PM10 W/CONDENSIBLES (%):	65.6	50.1	82.1	65.9

AMTEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 1, 2, 3A, 4 AND 201A
AM TEST - AIR QUALITY, INC.

FILE NAME: S708\BALL5SM
CLIENT: Ball Glass Container Corporation
LOCATION: Seattle, Washington

	FURNACE #5 STACK			
	RUN #1	RUN #2	RUN #3	AVERAGE
LAB #:	5748	5749	5750	
DATE:	5/20/94	5/20/94	5/20/94	
START TIME:	10:23	13:22	16:05	
STOP TIME:	12:32	15:25	18:10	
SAMPLE LENGTH (minutes):	119.84	116.90	114.20	
VOLUME SAMPLED (cubic feet):	48.947	46.687	45.984	47.206
VOLUME SAMPLED (dry std. cubic feet):	49.887	47.261	46.399	47.849
VOLUME SAMPLED (dry std. cubic meters):	1.413	1.338	1.314	1.355
STACK GAS MOISTURE (percent):	7.41	7.31	7.47	7.40
BAROMETRIC PRESSURE (inches of Hg):	30.00	30.00	30.00	30.00
STATIC PRESSURE (inches of H2O):	-0.25	-0.24	-0.25	-0.25
STACK PRESSURE (inches of Hg):	29.98	29.98	29.98	29.98
STACK GAS TEMPERATURE (degrees F.):	428.5	434.9	431.3	431.6
STACK GAS TEMPERATURE (degrees R.):	888.5	894.9	891.3	891.6
CARBON DIOXIDE (percent):	5.6	5.3	5.2	5.4
OXYGEN (percent):	19.4	19.6	19.6	19.5
CARBON MONOXIDE (ppm):	2.9	2.8	3.1	2.9
MOLECULAR WEIGHT (dry, g/g-mole):	29.67	29.63	29.62	29.6
MOLECULAR WEIGHT (wet, g/g-mole):	28.81	28.78	28.75	28.8
GAS VISCOSITY (micropoises):	265.4	267.2	266.2	266.3
AVERAGE VELOCITY HEAD (inches of H2O):	0.304	0.292	0.275	0.290
PITOT TUBE Cp:	0.84	0.84	0.84	
STACK GAS VELOCITY (feet per second):	40.1	39.5	38.3	39.30
STACK DIAMETER (inches):	41.5	41.5	41.5	
STACK AREA (square feet):	9.39	9.39	9.39	
STACK GAS AIRFLOW (dry std. cubic feet per min.):	12473.4	12210.2	11865.3	12183.0
STACK GAS AIRFLOW (actual cubic feet per min.):	22624.6	22280.0	21599.9	22168.2
NOZZLE DIAMETER (inches):	0.215	0.233	0.233	
ISOKINETICS (percent):	124	105	109	
CUT-POINT DIAMETER (D50):	10.04	10.27	10.22	10.18
> PM10 PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.0009	0.002	0.001	0.001
> PM10 PARTICULATE MATTER EMISSION RATE (lb/hr):	0.093	0.242	0.129	0.155
< PM10 PARTICULATE MATTER CONC. W/O CONDENSIBLES (gr/dscf):	0.021	0.021	0.020	0.021
< PM10 PARTIC. MATTER EMISSION RATE W/O CONDENSIBLES (lb/hr):	2.24	2.23	2.07	2.18
< PM10 PARTICULATE MATTER CONC. W/CONDENSIBLES (gr/dscf):	0.026	0.025	0.022	0.024
< PM10 PARTIC. MATTER EMISSION RATE W/CONDENSIBLES (lb/hr):	2.76	2.57	2.26	2.53
TOTAL PARTICULATE MATTER CONCENTRATION (gr/dscf):	0.027	0.027	0.023	0.026
TOTAL PARTICULATE MATTER CONCENTRATION (mg/dscm):	61.1	61.4	53.7	58.7
TOTAL PARTICULATE MATTER EMISSION RATE (lb/hr):	2.86	2.81	2.39	2.69
PERCENT PARTICULATE MATTER < PM10 W/O CONDENSIBLES (%):	96.0	90.2	94.1	93.4
PERCENT PARTICULATE MATTER < PM10 W/CONDENSIBLES (%):	96.7	91.4	94.6	94.2

2.2 EPA Method 6C, 7E and 10 - Sulfur Dioxide, Nitrogen Oxides and Carbon Monoxide

Sulfur dioxide (SO_2), nitrogen oxides (NO_x) and carbon monoxide (CO) data were recorded at 1-minute intervals during the PM_{10} test periods using instrumental analyzers. Three (3) Method 6C, 7E and 10 tests were performed concurrent with the Method 1-5/201A tests on May 17-20, 1994 at the exhaust stacks for Furnaces #2, #3, #4 and #5. The SO_2, NO_x and CO data are presented on the following computer printouts titled "Summary of Results - Methods 6C, 7E and 10".

The 1-minute SO_2, NO_x and CO data were averaged, and the average values were bias-corrected for calibration drift during each test. The data are presented in emission concentration units of dry parts per million (ppm) and in emission rate units of pounds per hour (lb/hr). Copies of the bias-corrected results for each Method 3A, 6C, 7E and 10 test are included in Appendix A of this report in printouts titled "Calibration Summary - Gaseous Emission Monitors". Copies of the 1-minute data are included in Appendix B of this report.

Table 2.2 Summary of gaseous emission test results from testing performed at the exhaust stacks of Furnaces #2, #3, #4 and #5 at Ball Glass Container Corporation in Seattle, Washington on May 17-20, 1994.

Sample Run #	SO_2 (ppm)	SO_2 (lb/hr)	O%	NO_x (ppm)		NO_x (lb/hr)	CO (ppm)	CO (lb/hr)
Furnace #2 (South)								
Run 1	71.9	3.72	18.9	83.5		3.11	229.8	5.20
Run 2	65.6	3.40	19.0	111.5		4.15	8.9	0.20
Run 3	66.2	3.32	19.0	109.7		3.95	3.5	0.08
Average	67.9	3.48	19.0	101.6		3.74	80.7	1.83
Furnace #2 (North)								
Run 1	45.1	2.65	18.9	44.7		1.89	159.7	4.11
Run 2	40.6	2.38	19.1	58.0		2.44	4.1	0.11
Run 3	40.7	2.42	19.2	46.3		1.98	0.2	0.01
Average	42.1	2.48	19.1	49.7		2.11	54.7	1.41
Furnace #2 (Avg)	55.0	16 SO2 / Ton		75.7		16 NOx / T	75.8	
Furnace #2 (Total)	5.96	.99		O2 (90)		5.85	.97	25.6 T/Yr 3.24
Furnace #3								
Run 1	22.7	4.88		34.6	20.2	5.35	0.1	0.01
Run 2	21.1	4.51		35.8	20.3	5.50	0.1	0.01
Run 3	21.7	4.73		32.0	20.3	5.01	0.0	0.00
Average	21.8	4.70	.68	34.1	20.3	5.29	T/Yr 23.2	0.1 0.01
Furnace #4								
Run 1	22.5	3.96		518.0	17.4	65.5	0.1	0.01
Run 2	21.6	4.87		515.5	16.7	83.6	0.1	0.01
Run 3	14.2	3.36		521.2	16.5	88.8	0.1	0.01
Average	19.4	4.06	.74	518.2	16.9	79.3 · 347.3	T/YR 0.1	0.01
Furnace #5								
Run 1	61.8	7.68		44.7	19.4	3.99	2.9	0.16
Run 2	72.7	8.84		47.3	19.6	4.14	17.9 TPY 2.8	0.15
Run 3	65.6	7.75		48.3	19.6	4.11	3.1	0.16
Average	66.7	8.09	1.49	46.8	19.5	4.08	.75	2.9 0.16

T/day 144.6 166.8 131.3 130.7

lb SO2/T lb NOx/T

NCC #2 5289 1.6 3.8

#5 5193 1.6 3.8

AM TEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 6C, 7E AND 10
AM TEST - AIR QUALITY, INC.

FILE NAME: Y503\BC#2SUMA
CLIENT: BALL GLASS CONTAINER CORPORATION
LOCATION: SEATTLE, WASHINGTON

	FURNACE #2 SOUTH STACK			
	RUN #1	RUN #2	RUN #3	AVERAGE
DATE:	5/17/94	5/17/94	5/17/94	
START TIME:	10:00	13:30	17:00	
STOP TIME:	12:00	15:30	19:00	
AIRFLOW (dry std. cubic feet per min.):	5191.7	5200.9	5032.5	5141.7
METHOD 6C - SULFUR DIOXIDE (SO2)				
SULFUR DIOXIDE CONCENTRATION (ppm):	71.9	65.6	66.2	67.9
SULFUR DIOXIDE EMISSION RATE (lb/hr):	3.72	3.40	3.32	3.48
METHOD 7E - NITROGEN OXIDES (NOx)				
NITROGEN OXIDES EMISSION CONC. (ppm):	83.5	111.5	109.7	101.6
NOx EMISSION RATE (lb/hr as NO2):	3.11	4.15	3.95	3.74
METHOD 10 - CARBON MONOXIDE (CO)				
CARBON MONOXIDE CONCENTRATION (ppm):	229.8	8.9	3.5	80.7
CARBON MONOXIDE EMISSION RATE (lb/hr):	5.20	0.20	0.08	1.83

AM TEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 6C, 7E AND 10
AM TEST - AIR QUALITY, INC.

FILE NAME: Y503\BC#2SUMB
CLIENT: BALL GLASS CONTAINER CORPORATION
LOCATION: SEATTLE, WASHINGTON

	FURNACE #2 NORTH STACK			
	RUN #1	RUN #2	RUN #3	AVERAGE
DATE:	5/17/94	5/17/94	5/17/94	
START TIME:	10:00	13:30	17:00	
STOP TIME:	12:00	15:30	19:00	
AIRFLOW (dry std. cubic feet per min.):	5894.3	5884.1	5978.6	5919.0
METHOD 6C - SULFUR DIOXIDE (SO2)				
SULFUR DIOXIDE CONCENTRATION (ppm):	45.1	40.6	40.7	42.1
SULFUR DIOXIDE EMISSION RATE (lb/hr):	2.65	2.38	2.42	2.48
METHOD 7E - NITROGEN OXIDES (NOx)				
NITROGEN OXIDES EMISSION CONC. (ppm):	44.7	58.0	46.3	49.7
NOx EMISSION RATE (lb/hr as NO2):	1.89	2.44	1.98	2.11
METHOD 10 - CARBON MONOXIDE (CO)				
CARBON MONOXIDE CONCENTRATION (ppm):	159.7	4.1	0.2	54.7
CARBON MONOXIDE EMISSION RATE (lb/hr):	4.11	0.11	0.01	1.41

AM TEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 6C, 7E AND 10
AM TEST - AIR QUALITY, INC.

FILE NAME: Y503\BC#3SUM
CLIENT: BALL GLASS CONTAINER CORPORATION
LOCATION: SEATTLE, WASHINGTON

	FURNACE #3 STACK			
	RUN #1	RUN #2	RUN #3	AVERAGE
DATE:	5/18/94	5/18/94	5/18/94	
START TIME:	09:30	12:25	15:05	
STOP TIME:	11:30	14:25	17:05	
AIRFLOW (dry std. cubic feet per min.):	21572.8	21454.5	21870.5	21632.6
METHOD 6C - SULFUR DIOXIDE (SO2)				
SULFUR DIOXIDE CONCENTRATION (ppm):	22.7	21.1	21.7	21.8
SULFUR DIOXIDE EMISSION RATE (lb/hr):	4.88	4.51	4.73	4.70
METHOD 7E - NITROGEN OXIDES (NOx)				
NITROGEN OXIDES EMISSION CONC. (ppm):	34.6	35.8	32.0	34.1
NOx EMISSION RATE (lb/hr as NO2):	5.35	5.50	5.01	5.29
METHOD 10 - CARBON MONOXIDE (CO)				
CARBON MONOXIDE CONCENTRATION (ppm):	0.1	0.1	0.0	0.1
CARBON MONOXIDE EMISSION RATE (lb/hr):	0.01	0.01	0.00	0.01

AM TEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 6C, 7E AND 10
AM TEST - AIR QUALITY, INC.

FILE NAME: Y503\BC#4SUM
CLIENT: BALL GLASS CONTAINER CORPORATION
LOCATION: SEATTLE, WASHINGTON

	FURNACE #4 STACK			
	RUN #1	RUN #2	RUN #3	AVERAGE
DATE:	5/19/94	5/19/94	5/19/94	
START TIME:	09:35	12:45	16:00	
STOP TIME:	11:35	14:45	18:00	
AIRFLOW (dry std. cubic feet per min.):	17650.0	22627.2	23788.6	21355.3
METHOD 6C - SULFUR DIOXIDE (SO2)				
SULFUR DIOXIDE CONCENTRATION (ppm):	22.5	21.6	14.2	19.4
SULFUR DIOXIDE EMISSION RATE (lb/hr):	3.96	4.87	3.36	4.06
METHOD 7E - NITROGEN OXIDES (NOx)				
NITROGEN OXIDES EMISSION CONC. (ppm):	518.0	515.5	521.2	518.2
NOx EMISSION RATE (lb/hr as NO2):	65.5	83.6	88.8	79.3
METHOD 10 - CARBON MONOXIDE (CO)				
CARBON MONOXIDE CONCENTRATION (ppm):	0.1	0.1	0.1	0.1
CARBON MONOXIDE EMISSION RATE (lb/hr):	0.01	0.01	0.01	0.01

AMTEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 6C, 7E AND 10
AM TEST - AIR QUALITY, INC.

FILE NAME: Y503\BC#5SUM
CLIENT: BALL GLASS CONTAINER CORPORATION
LOCATION: SEATTLE, WASHINGTON

	FURNACE #5 STACK			
	RUN #1	RUN #2	RUN #3	AVERAGE
DATE:	5/20/94	5/20/94	5/20/94	
START TIME:	10:20	13:20	16:00	
STOP TIME:	12:20	15:20	18:00	
AIRFLOW (dry std. cubic feet per min.):	12473.4	12210.2	11865.3	12183.0
METHOD 6C - SULFUR DIOXIDE (SO2)				
SULFUR DIOXIDE CONCENTRATION (ppm):	61.8	72.7	65.6	66.7
SULFUR DIOXIDE EMISSION RATE (lb/hr):	7.68	8.84	7.75	8.09
METHOD 7E - NITROGEN OXIDES (NOx)				
NITROGEN OXIDES EMISSION CONC. (ppm):	44.7	47.3	48.3	46.8
NOx EMISSION RATE (lb/hr as NO2):	3.99	4.14	4.11	4.08
METHOD 10 - CARBON MONOXIDE (CO)				
CARBON MONOXIDE CONCENTRATION (ppm):	2.9	2.8	3.1	2.9
CARBON MONOXIDE EMISSION RATE (lb/hr):	0.16	0.15	0.16	0.16

3.0
PROJECT OVERVIEW/EXCEPTIONS

Method 201A allows the percent isokinetics to range from 80 to 120% (100 $\pm$ 20%). Due to large fluctuations in the flow, the percentage isokinetics for runs 2 and 3 at Furnace #4, and run 1 at Furnace #5 fell outside the acceptable range. The percent isokinetics for all other Method 201A tests fell within the acceptable range. An acceptable leak check preceded and followed each run.

Furnace #4 is a conventional regenerative furnace, and is equipped with an inlet duct which introduces dilution air to the stack, thereby creating a negative pressure on the process which helps pull exhaust gas from the process up the stack. Since the introduction of this dilution air accounts for dilution of the emission concentration, the airflow from the dilution duct was calculated and subtracted to attain a representative particulate matter emission concentration for the furnace. During each Method 201A/PM_{10} test at Furnace #4, the velocity in the dilution duct was measured at 12 points through the side and top ports.

During the testing at Furnaces #4 and #5, the PM_{10} cyclone was rinsed first with acetone, then with deionized water. The rinses were placed in separate sample bottles. (The particulate matter would not clean up with acetone but dissolved easily in water.) Both rinses were evaporated and the net weight was added to the $> PM_{10}$ catch.

Since the emissions for Furnace #2 exhaust through 2 stacks, emission rates were presented with the two stack's emissions combined.

4.0
SOURCE OPERATION/PROCESS DESCRIPTION

Ball Glass Corporation operates a glass container manufacturing facility in Seattle, Washington. The major glass-making raw materials, consisting of sand, soda ash and limestone, along with lesser quantities of colorants and refining agents, are received by rail or truck and unloaded into storage silos until needed. Recycled glass, called cullet, from the process (rejects) and purchased from recycling centers and other outside sources, is also a major raw material. Batch materials in carefully weighed proportions are thoroughly mixed and conveyed to storage bins above each glass melting furnace, essentially a box constructed of special high-temperature resistant refractories, containing a bath of molten glass at a temperature of about 2500° F. Temperatures above the glass melt reach 2700 to 2800° F.

The Seattle plant operates five glass melting furnaces. Most of the energy for melting and refining glass is supplied by natural gas fired burners, with additional energy provided as needed from electricity through electrodes immersed in the glass. One furnace (#1) utilizes electricity for 100% of its energy requirement. Furnace #4 is a conventional gas-fired furnace of the regenerative type, in which combustion products are exhausted through one of two chambers containing refractory brick for reclamation of heat; air for combustion passes through the other side and into the furnace to be mixed with fuel for heating the furnace. Every 20 minutes, the process is reversed, with the previously heated chamber now used to preheat combustion air while hot combustion products pass through the cooler side to again heat the refractory packing. Furnaces #2, #3 and #5 are designed to burn the natural gas with 100% oxygen (oxyfuel) utilizing special burners; these furnaces have no regenerators. Oxygen is supplied by an on-site cryogenic oxygen plant. Fuel flow and air/fuel of oxygen/fuel

ratio are carefully controlled to maintain proper furnace temperatures and efficient combustion. On furnaces #3, #4 and #5, induced draft fans are used to exhaust the products through a stack to the atmosphere. Furnace #2 exhausts through two (2) natural draft stacks.

Chemical reactions occur at these high temperatures over a period of several hours to form glass. The refining process (removal of trapped gases and bubbles) and homogenization of the glass takes place both during and after melting. Nearly bubble-free glass is continually withdrawn from the other end of the furnace and flows through shallow refractory channels called forehearths to the forming machines where bottles and jars are made. The freshly formed containers are heat-treated to remove any stresses in the forming process, inspected, packed and shipped to the customers. This operation goes on 24 hours a day, 7 days a week.

Ball-InCon Glass Packaging Corp.
Seattle, WA

Furnace Operating Data - Compliance Tests

	#2	#3	#4	#5
Test Date	5/17/94	5/18/94	5/19/94	5/20/94
Pull Rate (Tons Glass/Day)	144.6	166.8	131.3	130.7
Natural Gas (CFH)	23710	21450	20800	19860
Oxygen (CFH)	48230	45600	air	43100
Electric Boost (KWH/hr)	0	1250	1421	0
Bridgewall Temp (°F)	2655	2705	2710	2714
% Cullet	39	22	47	45
Glass Color	Flint	Dead Leaf Green	Amber	Flint
Batch Composition				
Silica Sand SiO_2	3547	3543	-	3547
Alumina Sand Al_2O_3	1199	1197	4813	1199
Soda Ash Na_2CO_3	1456	1499	1400	1456
Limestone $CaCO_3$	1250	1247	1263	1250
Salt Cake Na_2SO_4	32.77	-	--	32.77
Carbon C	1.55	6.62	7.7	1.55
Iron Chromite $FeCr_2O_4$	-	2.96	-	-
Iron Pyrites FeS_2	-	3.75	12.53	-
Decolorizer Mix	1.25	-	-	1.25

$\frac{64}{119.98} = 53.3\%$

6/3/94
opdata94.sea

Sodium Sulfate
Na_2SO_4

5-18-94

Furnace #

OPAC - 3

20PAC - 5

30PAC - 4

#3 Tested

time	7:38,	OPAC	5.2	20PAC	4.5	30PAC	3.5	
time	7:39,	OPAC	5.5	20PAC	4.6	30PAC	3.5	
time	7:40,	OPAC	5.0	20PAC	4.5	30PAC	3.8	
time	7:41,	OPAC	5.2	20PAC	4.5	30PAC	3.9	
time	7:42,	OPAC	5.0	20PAC	4.5	30PAC	3.6	
time	7:43,	OPAC	4.9	20PAC	4.6	30PAC	3.8	
time	7:44,	OPAC	4.9	20PAC	4.5	30PAC	3.8	
time	7:45,	OPAC	4.7	20PAC	4.5	30PAC	3.9	
time	7:46,	OPAC	4.8	20PAC	4.5	30PAC	3.8	
time	7:47,	OPAC	5.2	20PAC	4.5	30PAC	3.6	
time	7:48,	OPAC	5.0	20PAC	4.6	30PAC	3.9	
time	7:49,	OPAC	5.0	20PAC	4.5	30PAC	2.6	
time	7:50,	OPAC	5.3	20PAC	5.0	30PAC	2.5	
time	7:51,	OPAC	5.2	20PAC	4.6	30PAC	2.8	
time	7:52,	OPAC	5.4	20PAC	4.4	30PAC	2.9	
time	7:53,	OPAC	5.7	20PAC	4.1	30PAC	2.9	
time	7:54,	OPAC	5.7	20PAC	3.8	30PAC	3.0	
time	7:55,	OPAC	5.7	20PAC	3.9	30PAC	3.1	
time	7:56,	OPAC	6.0	20PAC	3.8	30PAC	3.1	
time	7:57,	OPAC	5.8	20PAC	4.2	30PAC	3.2	
time	7:58,	OPAC	5.7	20PAC	4.0	30PAC	3.3	
time	7:59,	OPAC	5.9	20PAC	4.1	30PAC	3.2	
time	8: 0,	OPAC	5.6	20PAC	4.3	30PAC	3.3	
time	8: 1,	OPAC	5.7	20PAC	4.5	30PAC	3.3	
time	8: 2,	OPAC	5.4	20PAC	4.2	30PAC	3.3	
time	8: 3,	OPAC	5.4	20PAC	4.0	30PAC	3.4	
time	8: 4,	OPAC	5.7	20PAC	4.2	30PAC	3.4	
time	8: 5,	OPAC	5.6	20PAC	4.5	30PAC	3.5	
time	8: 6,	OPAC	5.3	20PAC	4.3	30PAC	3.6	
time	8: 7,	OPAC	5.6	20PAC	3.9	30PAC	3.7	
time	8: 8,	OPAC	5.6	20PAC	3.7	30PAC	3.8	
time	8: 9,	OPAC	5.8	20PAC	3.3	30PAC	2.6	
time	8:10,	OPAC	5.8	20PAC	3.0	30PAC	2.8	
time	8:11,	OPAC	5.6	20PAC	3.3	30PAC	3.0	
time	8:12,	OPAC	5.7	20PAC	3.9	30PAC	3.0	
time	8:13,	OPAC	5.8	20PAC	3.6	30PAC	3.1	
time	8:14,	OPAC	5.9	20PAC	3.3	30PAC	3.3	
time	8:15,	OPAC	5.9	20PAC	3.2	30PAC	3.1	
time	8:16,	OPAC	5.5	20PAC	3.4	30PAC	3.3	
time	8:17,	OPAC	5.8	20PAC	3.7	30PAC	3.4	
time	8:18,	OPAC	5.5	20PAC	4.0	30PAC	3.4	
time	8:19,	OPAC	5.4	20PAC	4.2	30PAC	3.4	
time	8:20,	OPAC	5.4	20PAC	3.8	30PAC	3.6	
time	8:21,	OPAC	5.4	20PAC	3.6	30PAC	3.6	
time	8:22,	OPAC	5.5	20PAC	3.8	30PAC	3.4	
time	8:23,	OPAC	5.8	20PAC	3.6	30PAC	3.8	
time	8:24,	OPAC	5.5	20PAC	3.5	30PAC	3.6	
time	8:25,	OPAC	5.6	20PAC	3.4	30PAC	3.6	
time	8:26,	OPAC	5.5	20PAC	3.4	30PAC	4.0	
time	8:27,	OPAC	5.2	20PAC	3.8	30PAC	3.7	
time	8:28,	OPAC	5.3	20PAC	3.8	30PAC	4.0	
time	8:36,	OPAC	5.5	20PAC	4.1	30PAC	2.8	
time	8:37,	OPAC	5.7	20PAC	4.7	30PAC	3.5	
time	8:38,	OPAC	5.7	20PAC	4.8	30PAC	3.4	
time	8:39,	OPAC	5.7	20PAC	4.7	30PAC	3.4	
time	8:40,	OPAC	5.7	20PAC	4.6	30PAC	3.5	
time	8:41,	OPAC	5.9	20PAC	4.7	30PAC	3.4	
time	8:42,	OPAC	5.3	20PAC	4.8	30PAC	3.6	
time	8:43,	OPAC	5.5	20PAC	4.9	30PAC	3.6	
time	8:44,	OPAC	5.8	20PAC	4.9	30PAC	3.6	
time	8:45,	OPAC	5.7	20PAC	4.9	30PAC	3.6	
time	8:46,	OPAC	5.5	20PAC	5.0	30PAC	3.6	
time	8:47,	OPAC	5.3	20PAC	5.0	30PAC	3.7	
time	8:48	OPAC	5.4	20PAC	4.5	30PAC	3.7	